Appendix I

Laser Beam Profiles

a better resolution than 1 in 10. In addition, the better resolution occurs near the region of greatest interest, the damage threshold. A drawback to this measurement method is the large number of sites that must be irradiated. Using this test on small samples remains difficult however, it may be useful on larger samples such as the 2-inch optics.

The third laser damage measurement was discussed by Bass [2] and may possibly be used to determine the probability of damage at levels below the measured damage threshold. This work is based on the premise that even below the "0"-probability of damage level a part will exhibit damage given enough shots. The basis for this assumption is that laser damage is a statistical process. At low fluences the probability of damage may be vanishingly small. However, if a system is expected to accrue many shots, damage may again become statistically important. In this measurement a part is irradiated with one shot in a chosen number of sites and the percentage of sites which fail is recorded. The percentage of sites which fail are plotted on a logarithmic scale and a curve fitted to the points.

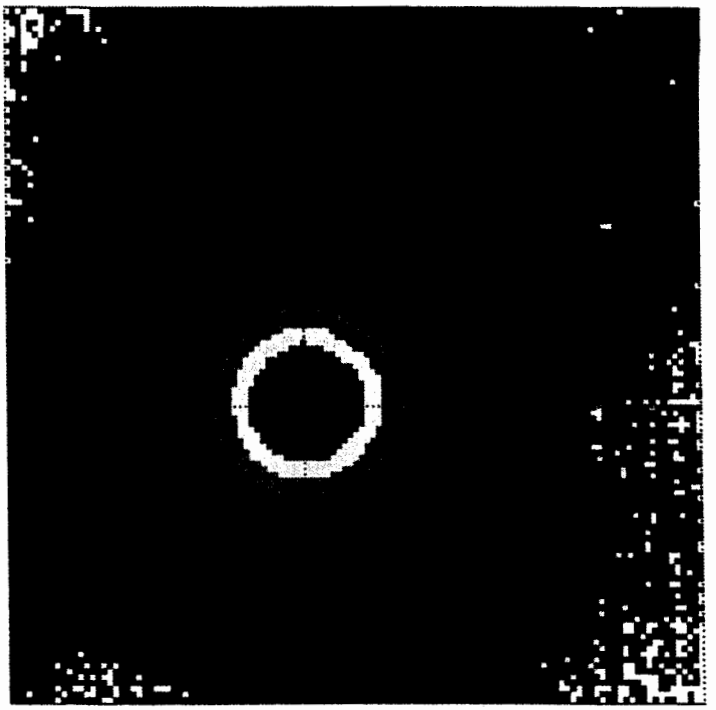
In this report all 10 of the laser mirrors were tested using the *DFM* method. Because of the large aperture of the parts, 5 samples measured using the *DFM* method were also measured using the *MDFM* method. This allowed a direct comparison between the results for the given test procedures. As part of this study 4 samples were laser conditioned after the initial *DFM* method. The parts again underwent a *DFM* test to determine the effect of the conditioning. The final sample was measured using *DFM* with the remainder of the part irradiated according to the Bass [2] technique.

3. Test Specifications

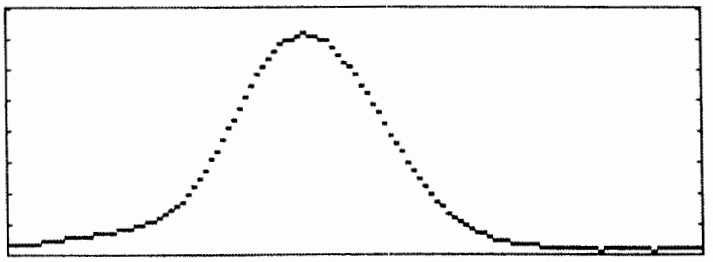
3.1 Test Setup

The following section describes the test setup and laser parameters utilized throughout this series of laser damage tests.

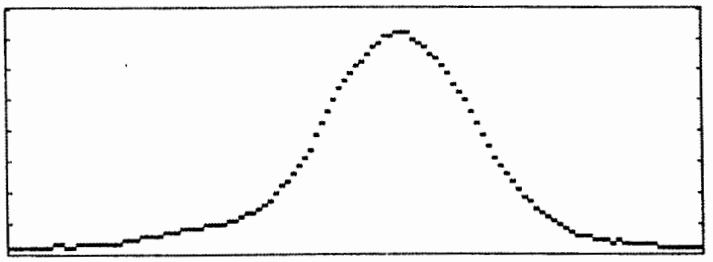
The laser source was a Gaussian reflectivity Nd:YAG oscillator. This system provided a Gaussian beam with better than 85% fit to Gaussian in the near field and better than 90% fit to Gaussian in the far field. This laser provided an output of 450 mJ at 1064 nm in a linearly polarized beam. The laser was operated with a PRF of 10 Hz with a 4 ns pulsewidth at the FWHM. The laser was passed through a 1/2 waveplate-thin film polarizer combination to allow for energy adjustment without thermally effecting the laser source. The laser energy was measured using a Scientech astral volumetric absorbing calorimeter capable of measuring 10 Watts of average power. A schematic of the experiment is shown in Figure 1. The laser was focused to a spot diameter of 1.01 mm using a slightly defocused Galilean telescope. This focusing system provides a long Rayleigh range mitigating beam size changes due to the possibility of a slight positioning error of the sample. The spot size was measured with a Spiricon LBA -100A beam analyzer. The beam analyzer provided a Gaussian fit and calculated the $1/e^2$ beam radius.

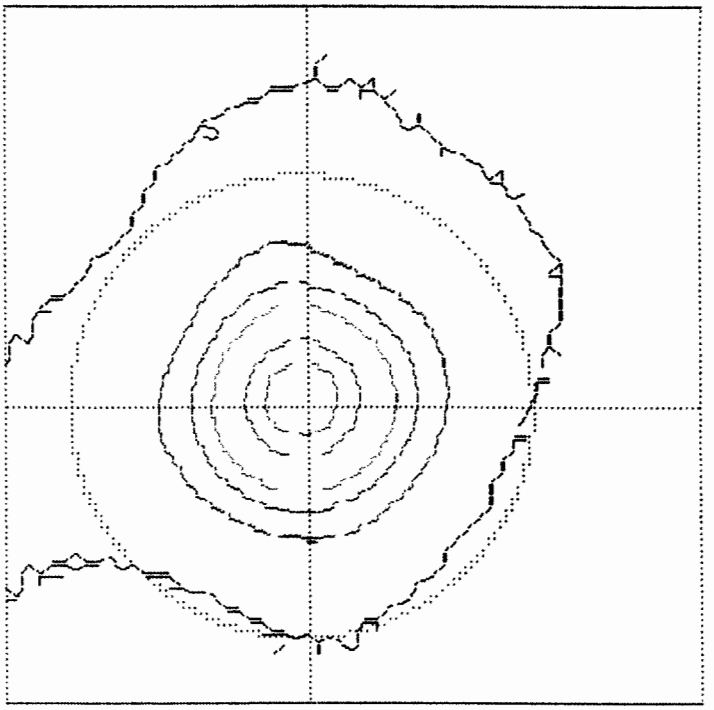


Horizontal Cursor Profile

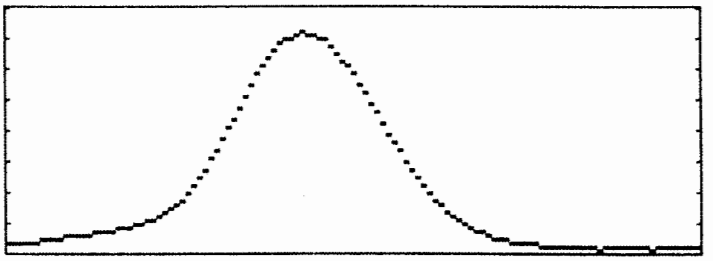


Vertical Cursor Profile

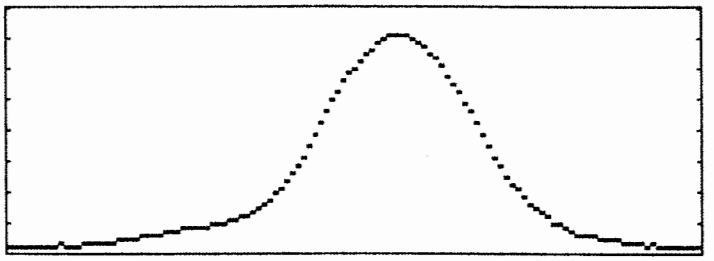




Horizontal Cursor Profile



Vertical Cursor Profile



D86e / Knife Edge Diameter Level

Total	88.36%	987772
Peak	3	227
Peak Location	(988.00,	1027.52)μm
Centroid	(1016.95,	1029.68)μm
Diameter		1127.70μm
X,Y	1090.94,	1080.41μm

Elliptical Beam

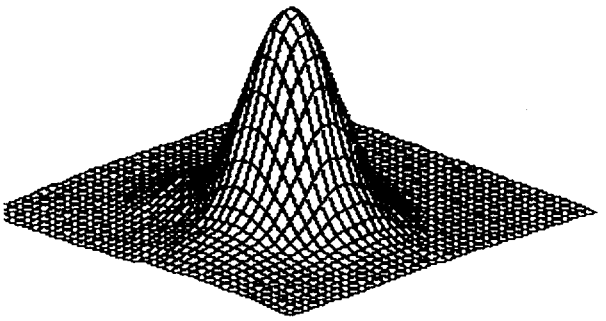
Orientation	-89
Roundness	0.990

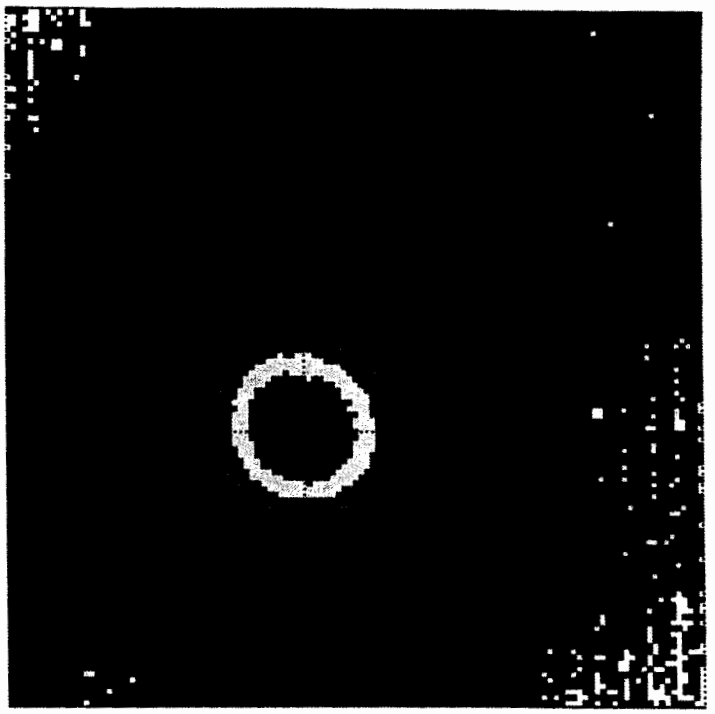
Gauss Fit M,m aligned

Center, Width	(11.51,	517.33)μm
Height		224
Correlation	0.49	0.942
center, width	(7.98,	514.45)μm
height		221
correlation	0.41	0.953

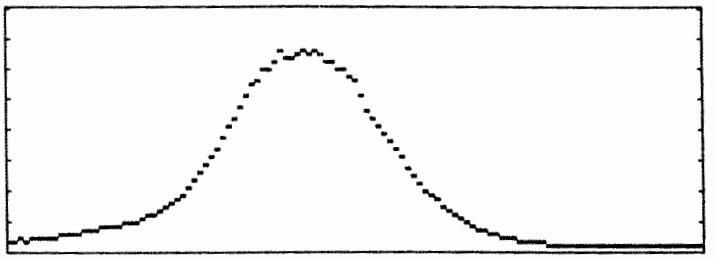
Frame number 1
2/28/97 08:25:22.82
Calibrated
Cursor (0.00, 0.00)
Aperture Circle
Center (1007.76, 997.88)
Diam 1580.80μm
Zoom: Medium
Pan Window (328, 88)
No Lens
Pixel Scale 9.88μm

Spiricon LBA-100A V4.54

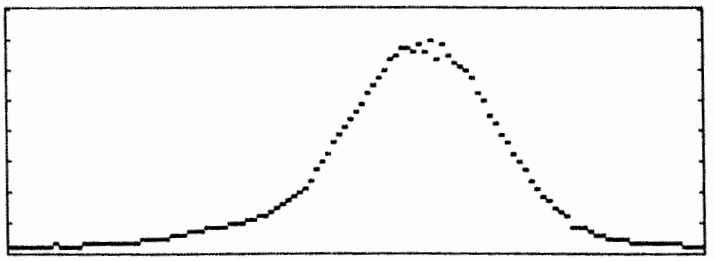




Horizontal Cursor Profile



Vertical Cursor Profile



)86e / Knife Edge Diameter Level

Total	87.93%	974736
Peak	3	213
Peak Location	(1027.52,	1007.76)μm
Centroid	(1012.30,	1008.44)μm
Diameter		1157.07μm
X,Y	1146.44,	1121.23μm

Elliptical Beam

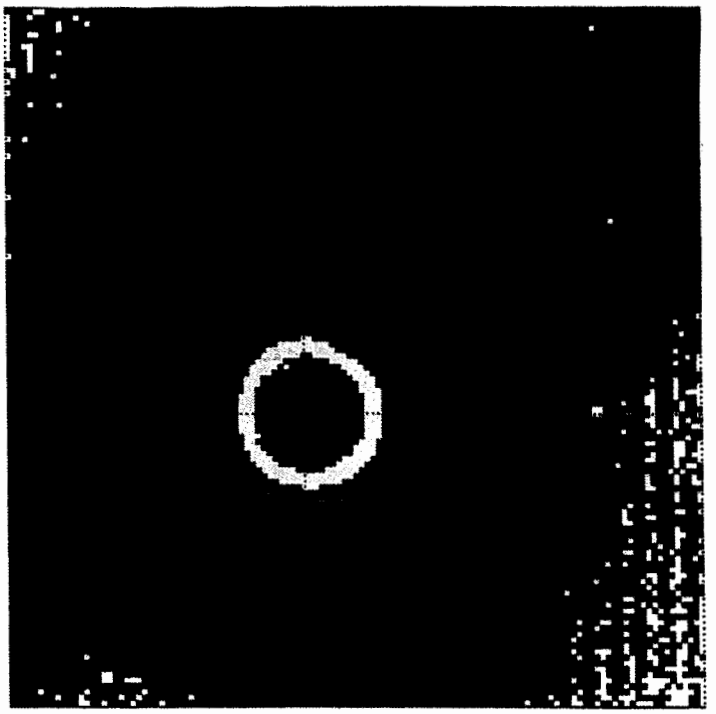
Orientation	75
Roundness	0.978

Gauss Fit M,m aligned

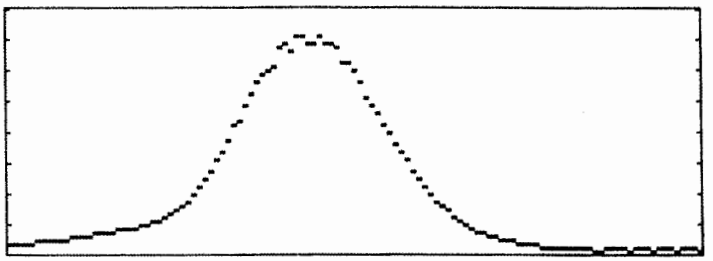
Center, Width	(-31.14,	527.72)μm
Height		207
Correlation	0.36	0.951
center, width	(17.09,	520.77)μm
height		203
correlation	0.40	0.949

Frame number 1
2/28/97 08:29:32.02
Calibrated
Cursor (988.00, 948.48)
Aperture Circle
Center (1007.76, 997.88)
Diam 1580.80μm
Zoom: Medium
Pan Window (328, 88)
No Lens
Pixel Scale 9.88μm

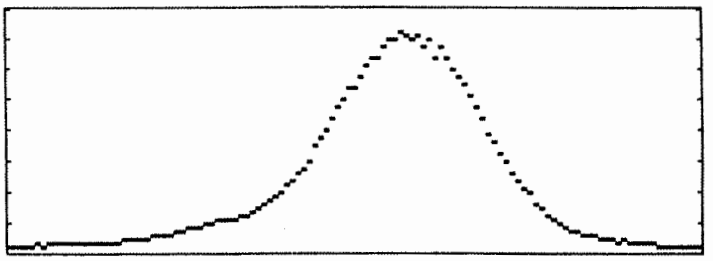
Spiricon LBA-100A V4.54



Horizontal Cursor Profile



Vertical Cursor Profile



D86e / Knife Edge Diameter Level

Total	88.17%	980136
Peak	3	228
Peak Location	(1007.76,	1007.76)μm
Centroid	(1021.21,	1011.20)μm
Diameter		1139.32μm
X,Y	1113.66,	1078.93μm

Elliptical Beam

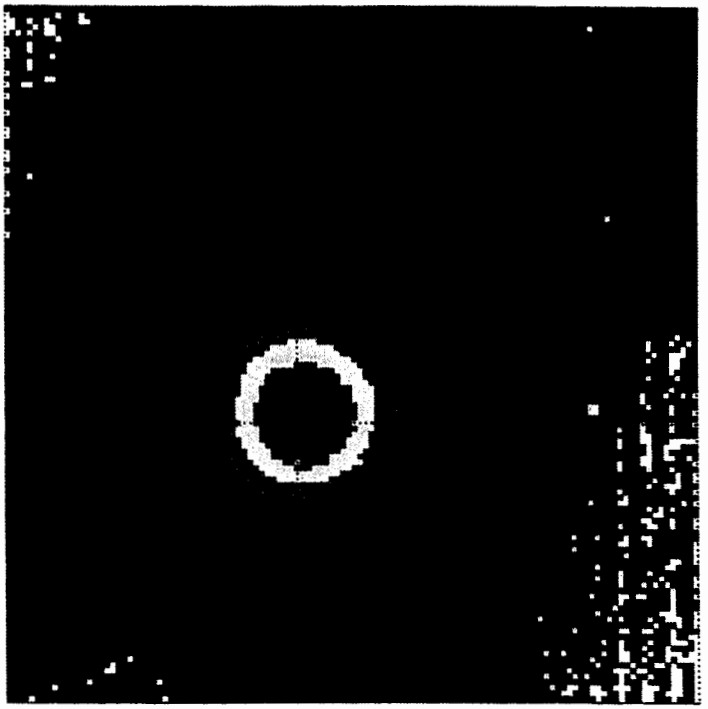
Orientation	-70
Roundness	0.969

Gauss Fit M,m aligned

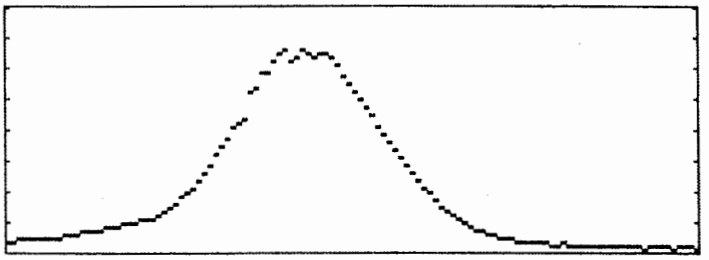
Center, Width	(26.00,	523.78)μm
Height		220
Correlation	0.63	0.927
center, width	(2.30,	499.59)μm
height		217
correlation	0.54	0.926

Frame number 2
2/28/97 08:30:00.88
Calibrated
Cursor (1007.76, 988.00)
Aperture Circle
Center (1007.76, 997.88)
Diam 1580.80μm
Zoom: Medium
Pan Window (328, 88)
No Lens
Pixel Scale 9.88μm

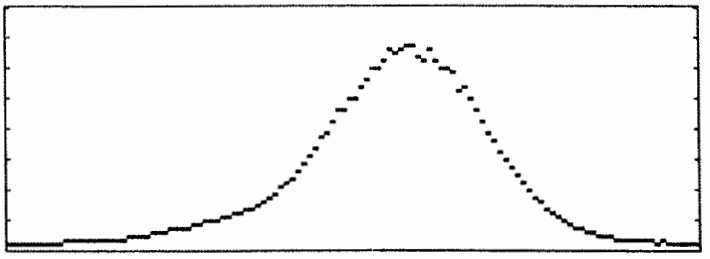
Spiricon LBA-100A V4.54



Horizontal Cursor Profile



Vertical Cursor Profile



D86e / Knife Edge Diameter Level

Total	88.36%	987772
Peak	3	227
Peak Location	(988.00,	1027.52)μm
Centroid	(1016.95,	1029.68)μm
Diameter		1127.70μm
X,Y	1090.94,	1080.41μm

Elliptical Beam

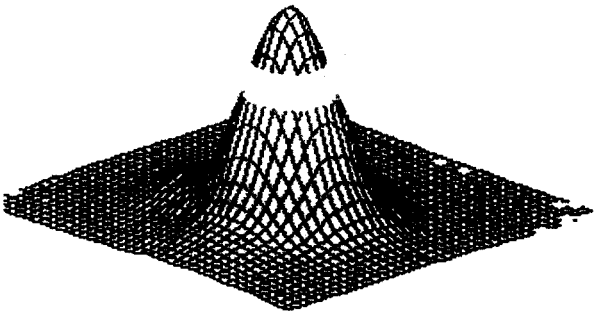
Orientation	-89
Roundness	0.990

Gauss Fit M,m aligned

Center, Width	(11.51,	517.33)μm
Height		224
Correlation	0.49	0.942
center, width	(7.98,	514.45)μm
height		221
correlation	0.41	0.953

Frame number 1
2/28/97 08:25:22.82
Calibrated
Cursor (0.00, 0.00)
Aperture Circle
Center (1007.76, 997.88)
Diam 1580.80μm
Zoom: Medium
Pan Window (328, 88)
No Lens
Pixel Scale 9.88μm

Spiricon LBA-100A V4.54



)86e / Knife Edge Diameter Level

Total	88.44%	985120
Peak	3	220
Peak Location	(1007.76,	1007.76)μm
Centroid	(1021.16,	1000.10)μm
Diameter		1141.50μm
X,Y	1133.00,	1069.32μm

Elliptical Beam

Orientation	-76
Roundness	0.944

auss Fit M,m aligned

Center, Width	(14.04,	545.39)μm
Height		214
Correlation	0.59	0.927
center, width	(5.11,	499.16)μm
height		214
correlation	0.48	0.937

rame number 1
2/28/97 08:29:13.37
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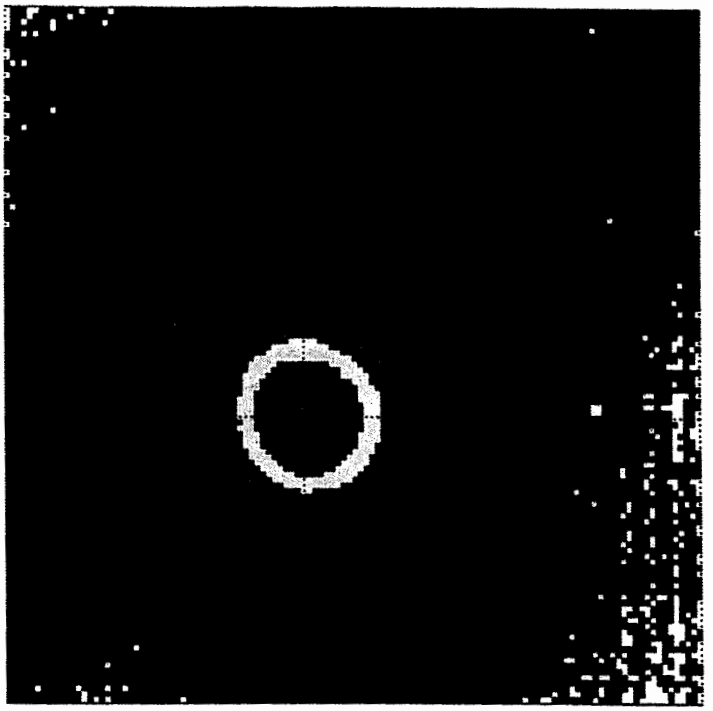
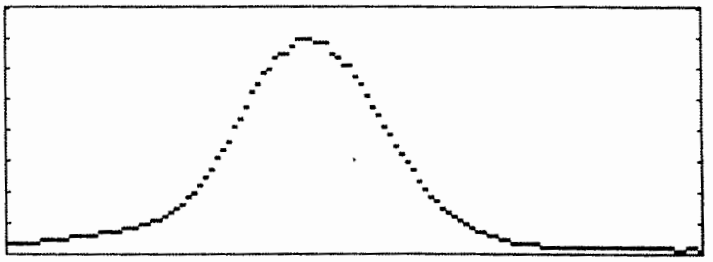
ixel Scale 9.88μm

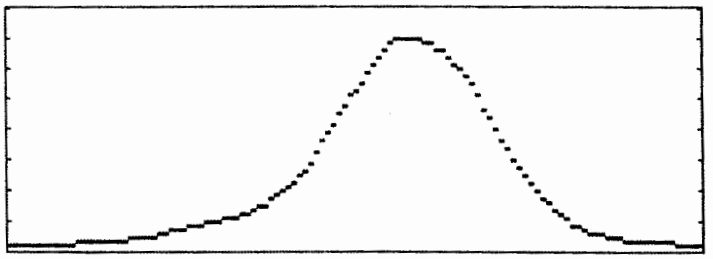
)iricon LBA-100A V4.54



Horizontal Cursor Profile



Vertical Cursor Profile



86e / Knife Edge Diameter Level		
Total	88.28%	978596
Peak	3	218
Peak Location	(968.24,	908.96)μm
Centroid	(995.08,	970.99)μm
Diameter		1159.00μm
X,Y	1144.34,	1118.44μm
Elliptical Beam		
Orientation		-56
Roundness		0.977
Gauss Fit	M,m aligned	
Center, Width	(31.79,	541.12)μm
Height		211
Correlation	0.43	0.935
center, width	(-8.38,	507.91)μm
height		209
correlation	0.38	0.941

rame number 1
2/28/97 08:28:49.31
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iam 1580.80μm
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an Window (328, 88)
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ixel Scale 9.88μm

piricon LBA-100A V4.54

)86e / Knife Edge Diameter Level

Total	88.36%	987772
Peak	3	227
Peak Location	(988.00,	1027.52)μm
Centroid	(1016.95,	1029.68)μm
Diameter		1127.70μm
X,Y	1090.94,	1080.41μm

Elliptical Beam

Orientation	-89
Roundness	0.990

Gauss Fit M,m aligned

Center, Width	(11.51,	517.33)μm
Height		224
Correlation	0.49	0.942
center, width	(7.98,	514.45)μm
height		221
correlation	0.41	0.953

'rame number 1
2/28/97 08:25:22.82
Calibrated
ursor (1007.76, 1007.76)
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Center (1007.76, 997.88)
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Pan Window (328, 88)
To Lens
ixel Scale 9.88μm

Spiricon LBA-100A V4.54